

CLAIMS

1. A method of electrochemically treating a substrate, which method comprises the steps of:

(a) providing an electrolyte in contact with the substrate;

(b) providing a device which faces the substrate and is in contact with the electrolyte, the device having:

(i) a common first electrode arranged to define cells therein; and

(ii) a plurality of individually addressable second electrodes,

wherein a plurality of the cells contain individually addressable second electrodes; and

(c) altering the potential of at least one of the second electrodes relative to the common first electrode so that:

(i) the common first electrode generates a first redox product; and

(ii) the at least one of the second electrodes generate a second redox product which is able to modify a region of the substrate facing the at least one electrodes,

wherein the electrolyte is such that the second redox product is quenchable by the first redox product.

2. The method of claim 1, wherein the quenching reaction between the first and second redox products regenerates one or more of the original substances in the electrolyte.

3. The method of any preceding claim, wherein the second redox product is an acid, a base, a radical, or a halogen.

4. The method of any preceding claim, wherein the substrate to be treated comprises a substance having an acid-labile protecting group or a base-labile protecting group.

5. The method of any preceding claim, wherein the first redox product is an anion.

6. The method of claim 5, wherein the anion is an organic radical anion.

7. The method of any preceding claim, wherein the electrolyte comprises: (a) Γ and $S_4O_6^{2-}$; (b) a ketone and a corresponding alcohol; (c) 2-propanone and iso-propanol; (d) benzophenone and benzhydrol; or (e) benzoquinone and hydroquinone.

8. The method of claim 7, wherein the electrolyte comprises a mixture of benzoquinone and hydroquinone in acetonitrile, and wherein the second redox product is a hydrogen ion.

9. The method of any preceding claim, wherein the electrolyte contains less than 25 mmolar of inert conductive salt.

10. The method of any preceding claim, wherein the substrate is the surface of a material which is separate from and facing the electrodes.

11. The method of any preceding claim, wherein the substrate material is impermeable.
12. The method of any preceding claim, wherein the substrate material is a glass, a plastic, a metal, a semiconductor, a silicon oxide or a gel.
13. A device for electrochemically modifying a substrate, the device having:
- 5 (i) a common first electrode arranged to define cells therein; and
- (ii) a plurality of individually addressable second electrodes,
- wherein:
- a plurality of the cells contain individually addressable second electrodes;
- the common first electrode and the plurality of second electrodes are in contact with an
- 10 electrolyte during use; and
- the electrolyte is such that the common first electrode is able to generate a first redox product, the second electrode is able to generate a second redox product, and the second redox product is quenchable by the first redox product.
14. The device of claim 13, wherein the common first electrode is a cathode and the second
- 15 electrodes are anodes.
15. The device of any one of claims 13-14, wherein the common first electrode is singly addressable such that the potential of the first electrode may be altered by addressing a single connection.
16. The device of any one of claims 13-14, wherein the common first electrode is a bus line which is neither switchable nor addressable.
- 20 17. The device of any one of claims 13-16, wherein the common first electrode has a geometry in which there is a substantially regular pattern, such as a grid, a net, a honeycomb, a series of intersecting circles or other tessellating shapes.
18. The device of any one of claims 13-17, wherein the arrangement of the common first electrode results in at least $n \times 10^6$ cells, where n is 0.5 or more.
- 25 19. The device of any one of claims 13-18, wherein the arrangement of the common first electrode is such that the distance between the centre of a cell and the centre of at least one of its immediate neighbour cells is less than 0.5 mm.
20. The device of any one of claims 13-19, wherein the second electrodes are addressed using a direct connection from an electrode to a bond pad on the perimeter of the device, by CMOS
- 30 switching circuitry, or by transistor-based circuitry.
21. The device of claim 20, wherein the second electrodes are addressed using TFT circuitry.

22. The device of any one of claims 13-21, wherein the distance between the centre of a second electrode and the centre of at least one of its neighbouring second electrodes is less than 0.5 mm.
23. The device of claim any one of claims 13-22, comprising at least $n \times 10^6$ second electrodes, where n is 0.5 or more.
- 5 24. The device of any one of claims 13-23, wherein the ratio of the number of cells to the number of second electrodes is less than 1.
25. The device of any one of claims 13-23, wherein the ratio of the number of cells to the number of second electrodes is more than 1.
- 10 26. The device of any one of claims 13-23, wherein the ratio of the number of cells to the number of second electrodes is substantially 1.
27. The device of claim any one of claims 13-26, wherein the common first electrode and second electrodes are made from materials independently selected from indium tin oxide, iridium, platinum, palladium, gold, silver, copper, nickel, zinc, titanium, tungsten, aluminium and alloys of these metals.
- 15 28. The device of claim 27, wherein the common first electrode and second electrodes comprise a coating of iridium on another material.
29. The device of any one of claims 13-28, wherein the support on which the second electrodes are positioned and the circuitry connecting the second electrodes are as found in liquid crystal display devices.
- 20 30. The device of any one of claims 13-29, wherein incorporated into a flow cell arrangement.
31. The method of any one of claims 1 to 12, or the device of any one of claims 13 to 30, for use in deprotecting a substrate in specific patterns.
32. The method or device of claim 31, for use in removing protecting groups from specific regions of a substrate to leave a pattern of deprotected groups, such that subsequent exposure of the deprotected groups to a reactant allows the deprotected groups to react with the reactant.
- 25 33. The method or device of claim 31, for use in combinatorial synthesis.
34. The method or device of claim 31, for use in the synthesis of libraries of small organic compounds bound to a surface.
35. The method or device of claim 31, for use in synthesising polymers.
- 30 36. The method or device of claim 34, for use in synthesising polynucleotides, polysaccharides, or polypeptides.

37. The method or device of claim 31, for etching of the substrate.

38. The method or device of claim 31, for use in the production of organic LED materials.

39. A method for preparing an array of polynucleotides comprises the steps of:

5 (1) providing a substrate having protecting groups on its surface and which faces the device of any one of claims 13 to 30 and is in contact with the electrolyte;

(2) switching a first set of second electrodes so as to generate a second redox product which exposes deprotected groups by removing a set of protecting groups from the substrate;

(3) coupling a nucleotide to the set of deprotected groups, the nucleotide comprising a protecting group; and

10 (4) repeating the sequence of steps (2) and (3) until the desired array has been generated.

40. The method of claim 39, wherein the second redox product is a proton and the protecting group is an acid-labile protecting group which protects a furanyl hydroxyl group.

41. A method for guiding a reagent along the face of a substrate in a desired path, wherein a device of any one of claims 13 to 30 is used to create redox products along the desired path, and wherein
15 the reagent moves into region(s) where the redox products are created.